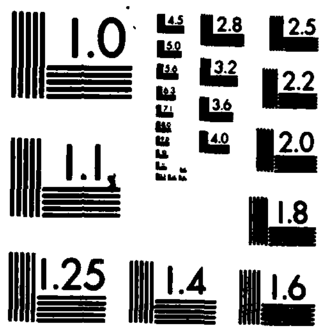
AD-A129 039 INCREASING FUTURE FIGHTER WEAPON SYSTEM PERFORMANCE BY 1/1
INTEGRATING BASING..(U) RAND CORP SANTA MONICA CA
M B BERMAN ET AL. APR 83 RAND/N-1985-1-AF
UNCLASSIFIED F49620-82-C-0018 F/G 1/3 NL

END
DATE
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12

A RAND NOTE

INCREASING FUTURE FIGHTER WEAPON SYSTEM PERFORMANCE BY INTEGRATING BASING, SUPPORT, AND AIR VEHICLE REQUIREMENTS

M. B. Berman with C. L. Batten

April 1983

N-1985-1-AF

Prepared for

The United States Air Force

35th Year

Rand
SANTA MONICA, CA 90406

The research reported here was sponsored by the Directorate of Operational Requirements, Deputy Chief of Staff/Research, Development, and Acquisition, Hq USAF, under Contract F49620-82-C-0018. The United States Government is authorized to reproduce and distribute reprints for governmental purposes notwithstanding any copyright notation hereon.

Published by The Rand Corporation

A RAND NOTE

INCREASING FUTURE FIGHTER WEAPON SYSTEM PERFORMANCE BY INTEGRATING BASING, SUPPORT, AND AIR VEHICLE REQUIREMENTS

M. B. Berman with C. L. Batten

April 1983

N-1985-1-AF

Prepared for The United States Air Force

35th Year
Rand
SANTA MONICA, CA 90406

PREFACE

This Note is a concept paper that has three main objectives. First, it aims at raising basing and support issues that need to be considered during the concept formulation phase for the new Advanced Tactical Fighter (ATF). Because many of these issues influence the ATF's basic design, deferring their consideration until later in the development cycle may foreclose their effect on the ATF. Second, the Note encourages comment on the suitability, direction, and scope of current research concerned with basing, support, and air vehicle design. Third, the issues and research approach described here are intended to help industry and the Air Force in formulating their concept development work. As the research unfolds, the findings will be shared with others conducting companion studies.

In addition, Rand's approach together with subsequent Air Force and industry studies should help the Air Force determine whether it should consider changes in its current basing structure and in its current support systems (particularly base, intermediate, and depot level maintenance).

The total set of research studies should also assist the acquisition community consider development modifications that will increase emphasis on basing and support issues. They can help the logistics community consider alternative logistics structures and arrangements that will be appropriate to the changed operating environment. And they can help the operations community consider new methods of operations that will be necessary for different basing structures. Ideally, these research studies will improve and integrate the many facets of support, acquisition, and operations planning required to develop new weapon systems.

This Note was prepared as part of a provisional study of "Alternative Basing, Support, and Design Concepts for Future Tactical Aircraft" (pending AFAG approval) within the Project AIR FORCE Resource Management Program.

SUMMARY

This Note argues that the Air Force should consider changes in basing and support characteristics concurrently and interactively with the concept formulation phase for the new Advanced Tactical Fighter (ATF). In so doing, it should integrate these changes using the kind of research methodology described here. This methodology could enable designers and manufacturers to identify the best match among specific air vehicle, basing, and support characteristics.

Current tactical fighters, such as the F-15 and F-16, rely heavily on large operating bases to provide them with extensive amounts of sophisticated support. This basing and support structure requires large amounts of supplies, test equipment, and personnel; and it often involves unusual and hard-to-handle materials. Reliance on large operating bases and sophisticated support can hamper mobility, create vulnerabilities, and decrease sortie generation, and these liabilities will increase as future enemies grow in number, technological sophistication, and geographical distribution.

To succeed in future combat situations, tactical fighters in general--and the ATF in particular--will need improved basing and support. Proposals for improvement include some dispersed or rearward basing. For many attractive basing options (as well as for operations from damaged runways and some austere third world locations), future tactical fighters will require STOL, rough field landing capabilities, or increased combat range capabilities. Survivability and sortie generation could be further enhanced by improved reliability and operation with minimal support equipment and personnel, especially at allied bases and austere third world locations.

Yet improved basing and support are hardly easy goals. First, one must **identify the necessary level of improvements** to be paid for with the least money and the least decrease in overall aircraft performance. Second--and most difficult--one must **integrate all improvements** to ensure that the tactical fighter can best profit from these improvements in future combat environments.

Such an integrated approach implies a new definition of "weapon system performance." In the past, definitions of weapon system performance have always stressed air vehicle characteristics (such as velocity, rate of climb, and acceleration) but have largely ignored basing and support innovations except to ensure that weapon systems could operate within the existing structure. In current and future environments, however, definitions of "weapon system performance" must integrate air vehicle characteristics with basing and support characteristics to ensure that weapon systems will have the best chance of deploying, generating needed sorties, and surviving attack.

ACKNOWLEDGMENTS

Many colleagues at The Rand Corporation have contributed to this work through their past efforts in trying to unravel the complex relationships among support systems, basing concepts, and weapon system performance.

Of most notable assistance have been the research endeavors of D. E. Emerson, F. Kozaczka, and J. Halliday in modelling air base attacks and analyzing their effects on support structure vulnerability; R. J. Hillestad, R. A. Pyles, and M. J. Carrillo in assessing combat capabilities of support resources; S. M. Drezner, I. K. Cohen, R. J. Kaplan, R. M. Paulson, and T. F. Lippiatt in evaluating alternative logistics structures; H. L. Shulman, J. R. Gebman, M. D. Rich, and G. K. Smith in designing acquisition strategies leading to improved equipment reliability; and N. W. Crawford, J. W. Ellis, and T. F. Kirkwood in exploring weapon system employment, deployment, and performance.

In addition, special thanks go to M. D. Rich and I. K. Cohen for their many suggestions and to R. M. Paulson for his helpful critique.

CONTENTS

FIGURES

I. INTRODUCTION

The Rand Corporation is currently undertaking a modest effort to determine not only certain *conceptual concerns* that should be addressed before arriving at precise designs for the new ATF, but also a *research methodology* to handle these concerns. This effort does not attempt to define the precise air vehicle, basing, and support requirements for the new Advanced Tactical Fighter (ATF); rather, it aims to serve as a useful conceptual and methodological guide for those in the Air Force and industry who must grapple with these difficult issues.

In particular, the Air Force should use an integrated conceptual approach when designing the ATF. It should evaluate the total weapon system by taking into consideration not merely air vehicle performance but also the support systems it should require and the basing structure from which the ATF should fly.

In many important respects, the operating bases currently employed by the U.S. Tactical Air Forces have slowly evolved through a series of gradual changes over the past 30 years. For the most part legacies of World War II and the Korean War, operating bases are typically complex, costly, and aging. Small cities in themselves, they often contain

- Complex diagnostic, support, and repair equipment for airplanes
- Large supply facilities for spare parts
- Sophisticated facilities for manufacturing and repairing support materials
- Extensive housing, recreational facilities, and shopping areas for personnel.

Their size and complexity are reflected in an average replacement cost of three-quarters of a billion dollars per base.

Although such large and complex operating bases and support structures made good sense in the past, they now face growing threats from increased enemy capabilities, they expose to attack large amounts

of critical personnel and equipment, and they limit the deployability of the aircraft they support. The size, combat value, and vulnerability of current operating bases make them prime targets for increasingly capable enemy aircraft and surface-to-surface missiles. Their fixed nature also makes them liable to sabotage and to attack by enemy air mobile forces and by chemical and biological munitions. Indeed, the 1970s saw the Soviets and their allies for the first time develop air power capable of attacking our air bases and their defenses (see "Soviet Aerospace Almanac," *The Air Force Magazine*, March 1982). Although they are worst in Europe, these growing threats now exist in all theaters and in several potential Third World contingencies.

To counter these threats, emphasis has so far mainly been placed on developing methods to protect current Main Operating Bases (MOBs) from enemy air attacks that use conventional munitions and to a lesser extent those that use air mobile forces and chemical and biological munitions. Yet since these MOBs would undoubtedly be lucrative, high-priority targets for enemy attack, especially if hundreds of aircraft were to deploy to them from the United States, increased protection though dispersal of aircraft has become increasingly necessary.

In areas where our allies have suitable MOBs of their own, we distribute Tactical Air Force squadrons to those bases (calling them Collocated Operating Bases or COBs). This approach improves survivability by dispersing assets across an increased number of bases. Since many of these COBs are however undoubtedly already on the enemy's list of targets, an even greater level of dispersal may become necessary to ensure survivability. Such increased dispersal could rely on the support capabilities of MOBs and COBs to add a large number of *new* and potentially uncertain operating targets to the enemy's list. Of course, any dispersal--using COBs or new dispersed locations--would greatly benefit from reducing the support tail that contributes to each unit's vulnerability and that hampers its sortie generation.

Highly capable airplanes such as the F-15 and F-16 have been specifically designed to rely on large amounts of specialized support that usually can be provided efficiently only by large MOBs. This greatly reduces wartime mobility and sortie generation whenever airplanes must deploy or redeploy, especially to Third World areas.

The F-15's dependence on an Avionics Intermediate Shop (AIS) is symptomatic of this current need for large amounts of specialized support. At least three C-141s are required to transport an AIS, and when in operation this AIS requires 4500 ft^2 of level, air-conditioned floor space. It consists of one station for the F-15's tactical electronic warfare equipment plus four manual and three automatic stations for the remaining avionics. The three automatic test stations alone cost $18 million per set, and a squadron needs at least two such sets to operate at optimal efficiency.

The F-15 and F-16 also rely on unusual and hard-to-handle support materials. For example, because high-pressure nitrogen is dry and retards oxidation, they us it to charge hydraulic system accumulators and to inflate struts and tires. Such nitrogen may be unavailable in some parts of the world during wartime, and even if it were available, its use requires specialized ground support equipment and personnel.

In sum, deployment of a typical F-15 squadron currently requires 13 to 18 C-141s to carry flight-line equipment and spares just to set up operations at a prepared MOB--and much more equipment and spares to set up at an unprepared base.

These requirements currently hamper mobility, create added vulnerabilities, and decrease the number of sorties that the F-15 can fly; and such requirements will become even more detrimental in the future as the weapons of our potential enemies grow in number, technological sophistication, and geographical distribution. Our current logistics structure evolved when the requirement was to generate one sortie (or less) per day per airplane operating out of a large U.S. MOB or safe allied COB.

Future combat situations will impose very different demands on tactical fighters. If already within the theater of action, they may have to survive a first attack of major proportions. If not already within the theater, they may have to deploy in less than 24 hours to distant places serviced only by austere bases. Because of the simultaneous deployment of ground troops, airlift capabilities for support equipment and personnel will probably be severely limited. In any event, the fighters will need to generate perhaps three to five

sorties almost immediately after the initial attack, and they will need to do so for sustained periods of time while under heavy fire.

To succeed in such situations, future tactical fighters in general--and the ATF in particular--will need improved ground survivability. Enhanced defenses at MOBs may contribute to this survivability, but greater survivability might derive from options that also include some dispersed and/or rearward basing. And for such basing (including operations from MOBs and COBs with damaged runways), future tactical fighters will require STOL, rough field landing capabilities, or increased combat range capabilities. In addition, they will need improved reliability and be able to operate with minimal amounts of support equipment and personnel. Meeting such goals, however, will scarcely be easy.

For one thing, each new capability may pose considerable costs, which will necessarily involve not only dollars spent in research, development, production, and the like, but also possible decreases in cruise, carriage, or maneuverability capabilities. For example, the Air Force could decide to design the ATF to generate its own compressed nitrogen and oxygen on board. Such a capability should greatly reduce the ATF's reliance on support equipment and personnel, but it might cost in the neighborhood of $20,000 per aircraft and add about 200 pounds. Such a weight addition might decrease the aircraft's ordnance load by a comparable amount, or decrease its combat radius by perhaps ten miles if not offset by, say, 300 pounds of additional fuel, engine weight, and structure.

In addition, each new capability will need to be integrated with other capabilities. It makes little sense to design the ATF with a STOL capability if the ATF requires extensive support from a MOB. If the ATF uses its STOL to take off and land on MOB runways that have been shortened by bombs, chances are that the MOB's support facilities have also received severe damage; if the ATF uses its STOL to take off and land on dispersed austere locations, these fields will lack the extensive support equipment it needs to maintain its combat essential equipment in working order. The ATF needs more than just the ability to take off and land on short fields: It also needs to be able to operate successfully from them. Any commitment to develop STOL capabilities

should entail further commitments to reduce the amount of ground support needed.

All such design decisions involve extremely difficult tradeoffs. One must of course determine the desired degree of increased capability to be paid for with the lowest cost (of dollars and decreased aircraft performance). But one must also ensure that the airplane will have the best chance of deploying, generating needed and mission-effective sorties, and surviving in future combat situations.

Such an approach implies a new definition of *overall weapon system performance*. In the past, tactical fighters (and their support forces) operated in environments that were not so demanding as they are today in terms of sortie generation, deployment requirements, or vulnerability to enemy attack. Hence, past definitions of weapon system performance always stressed air vehicle characteristics (velocity, rate of climb, acceleration, etc.) but largely ignored competitive basing and support innovations and their consequences for air vehicle performance. Weapon system performance must now encompass not merely air vehicle characteristics but also *basing* and *support* characteristics. However, integrating these characteristics involves difficult tradeoff issues that have not been explicitly addressed before. The Air Force therefore needs a new methodology to assess this new kind of weapon system performance.

This Note proposes to address this need in two ways:

1. The Air Force should consider changes in basing and support characteristics during and in concert with the concept formulation phase for the new ATF, which will be fielded in the 1990s. The ATF--and indeed all future tactical fighters--should be able to operate in major theaters--for example, NATO and Korea (where MOBs will be extremely vulnerable)--and in minor theaters--such as Southwest Asia and Sub-Sahara Africa (where deployment will pose serious support problems). To operate safely and effectively in both kinds of theaters the ATF will need to be more capable of protective dispersal and less dependent on maintenance support than are current tactical fighters.

2. For fighter weapon systems operating in the 1990s and beyond, the Note describes a generic research methodology that can help ensure the best match among air vehicle, basing, and support characteristics. Using this approach, airframe manufacturers could conduct tradeoff studies of their specific designs. This research approach rests on the belief that decisions about air vehicle, basing, and support characteristics must be *integrated*.

Section II examines several proposals to *increase the basing options* for future tactical fighters: giving them STOL and rough field capabilities or increasing their combat-range capabilities over those currently enjoyed by tactical fighters. Section III looks at several proposals to *minimize support required* for future tactical fighters: increasing the reliability of equipment (especially avionics and engines), increasing onboard builtin support equipment, and decreasing reliance on support personnel. Section IV describes a research methodology to determine the assets and liabilities of each basing and support requirement when they compose part of an integrated package. Section V then suggests how this research methodology can be used during the concept development phase for the ATF.

II. INCREASING BASING OPTIONS FOR FUTURE FIGHTER WEAPON SYSTEMS

The two most promising proposals to increase basing options for future tactical fighter weapon systems[1] involve designing them so they will have STOL and rough-field-landing capabilities, or increased combat range capabilities, or both. If unable to afford both, we must choose the more promising one and determine its contribution to survivability and access to Third World areas.

SHORT TAKEOFF AND LANDING AND ROUGH FIELD LANDING CAPABILITIES

Future tactical fighters probably need at least some moderate degree of STOL to

- Improve their ability to operate from damaged MOB runways
- Achieve a dispersal option in developed areas, and
- Fight in many Third World areas.

In addition, future tactical fighters may also need at least some moderate rough field landing capabilities for greater ability to fly from damaged and austere runways.

Some degree of STOL and rough field capability can improve the ability of future tactical aircraft to operate from MOBs and COBs with damaged runways. In addition, these capabilities would open previously foreclosed possibilities in the Third World, where aircraft could operate from shorter rough fields or even from highways and other level semiprepared areas.

If the STOL capability fell within the 1500 to 3000 foot range (about half the F-15 requirement), a dispersal option centered around

[1] Throughout this section, future tactical fighter mission requirements are closer to those of the F-15/16/111 aircraft than to the VTOL Harrier or a long range missile platform. Either of these two extremes would require a different approach to basing.

current MOBs and COBs might become plausible. The Federal Republic of Germany (FRG) has nearly 50 military bases with runways over 5000 feet. These bases from which U.S. and allied air forces would typically operate constitute the major part of the central region's target set for the enemy. If a STOL capability of 2000 ft is feasible,[2] about 150 hard-surfaced runways now become available in the FRG (excluding runways within 50 km of the eastern border). And if rough field landing gear and tires are included in the design, over 100 grass and graded earth strips become available. In total, the target set for the enemy could be increased three- to six-fold (or even more if straight segments of the Autobahn were included), and such a dispersal option might even allow for a kind of shell-game dispersal.

STOL and rough field capabilities will not, however, come cheap. They will inevitably degrade some air vehicle characteristics by increasing takeoff gross weight and drag, and they will probably add to development and production costs. Finding the right tradeoff will not merely involve knowing how much STOL is technically feasible but also how much ground survivability and improved Third World operating capabilities should be bought at the expense of dollars and decreased air vehicle performance.

INCREASED COMBAT RANGE CAPABILITIES

Design for future tactical fighters might also aim at increasing their combat range, thereby allowing them to be based further from the battlefront and thus out of the optimum payload range of enemy aircraft. In Europe, for example, this would mean basing tactical fighters in Spain and the United Kingdom. For conflicts in Third World areas, this would mean making fighters somewhat less reliant on austere bases because they could engage distant enemies from rearward MOBs.

Increased combat range will also degrade some performance characteristics, such as ordnance load and maneuverability. Finding the right tradeoff will require examining the similar constraints, as for STOL and rough field capabilities.

---

[2] This would require a landing roll of from 1300 to 1800 ft and include an allowance for variations in actual point of touch down.

Any decision to increase combat range must be balanced against the decision to invest in STOL and rough-field-landing capabilities. In Third World areas, an increased range would give tactical fighters the option of operating from a few available MOBs potentially far from battle areas; STOL and rough-field capabilities, however, would give them the option of operating from more numerous and dispersed austere locations potentially closer to battle areas.

Uncertainties persist concerning the liabilities and assets that might result either from the dispersed basing that STOL and rough-field-landing capabilities would allow or from the rearward basing that an increased combat-range capability would allow. Indeed, all such uncertainties cannot be dealt with unless one integrates such considerations with the specific kinds of support requirements that future tactical fighters will possess.

III. MINIMIZING SUPPORT REQUIREMENTS FOR FUTURE FIGHTER WEAPON SYSTEMS

The three most promising proposals to minimize support for future tactical fighter weapon systems involve efforts to

1. Increase the reliability of equipment
2. Increase onboard built-in support
3. Decrease reliance on support personnel.

All three proposals need to be examined in terms of how they affect each other and the increased basing options discussed in Sec. II.

INCREASED RELIABILITY OF EQUIPMENT

Although increasing the reliability[1] of a future tactical fighter will undoubtedly be expensive and time-consuming, such increases can potentially ensure successful dispersal plus ground survivability, enhanced sortie generation, mission success, and some ultimate reductions in life cycle costs.

The experiences of the Air Force with its Minuteman I inertial guidance subsystem show that attempts to increase the reliability of equipment have in the past led to considerable payoffs. Although the Air Force aimed at developing this subsystem so that it would enjoy a high mean time between removal (MTBR), it initially had one of only 600 hours. On an average of once every 25 days the Air Force had to remove the Minuteman's inertial guidance equipment from the silo and send it to Newark, Ohio. Each time, the missile was out of service for roughly seven days because of the time required to remove the guidance subsystem and replace it with a new one, which then had to be warmed up and calibrated. Even if the Air Force had unlimited spare guidance subsystems, about one-fourth of its missiles would be unavailable at any

---

[1] Increased reliability involves improving not merely the airplane's time between failures but also its fault detection and fault isolation equipment and techniques. All such improvements are usually measured by changes in the time interval between removals.

given time. And because spares were in very short supply, many more missiles were unavailable.

In light of this extremely serious problem, the Air Force initiated a second development cycle aimed exclusively at improving the inertial guidance subsystem's MTBR. It succeeded in achieving an MTBR of 9000 hours, which allowed the average Minuteman to stay in the field over one year. Although this additional development cost $150 million, in the long run it saved some $1.5 billion.[2] But more important, it increased the availability of the missile force from 70 percent to over 95 percent.

Analogous improvements for tactical fighters could reap similar benefits. If the reliability of avionics and airplane engines could be doubled, for example, much specialized ground test equipment, spare parts, and ground personnel would no longer need to be deployed. This in turn would make deployment faster and increase the ability of fighters to operate from dispersed and rearward bases.

Any decision to pursue such a route to increase equipment reliability must be balanced against its inherent costs, the costs of other proposals to minimize support requirements, and the gains that they all potentially yield for both dispersed and rearward basing.

INCREASED BUILTIN SUPPORT

Most modern aircraft rely on large amounts of Aerospace Ground Support Equipment (AGE)--start carts, hydraulic mules, bomb jammers, air conditioners for avionics, liquid oxygen (LOX) carts, nitrogen carts, 400 cycle power generators, and air compressors--for service or repair.

Elimination of such AGE through builtin units could potentially improve sortie generation. For example, most modern aircraft require hydraulic bomb jammers to load bombs. But these jammers may be unavailable for any number of reasons: They may not have been deployed, they may malfunction, they may have been destroyed by enemy fire, the personnel who operate them may be unavailable, and so on. A tactical fighter cannot, however, perform its combat mission without a jammer. The absence of a jammer--for whatever reason--can effectively keep an otherwise combat-ready fighter from doing its job.

---

[2] Cost estimates are expressed in then-year dollars.

Much of this AGE is involved in providing a ready supply of unusual support materials, such as compressed nitrogen, LOX, Hydrazine, and HALON. Compressed nitrogen is currently used to charge hydraulic system accumulators and inflate struts. LOX provides an efficient way of carrying supplies of air crew oxygen, Hydrazine serves as a fuel in emergency power units, and HALON prevents explosions when sprayed into fuel tanks before each combat engagement. Reliance on such materials, however, will pose serious liabilities when aircraft are dispersed or when they find themselves in Third World areas where such materials will be unavailable and, in some cases, dangerous to handle and store.

Less esoteric--but certainly as critical--are the tactical fighter's tires, which currently must be replaced as often as once every 10 landings. When deploying, a fighter squadron currently carries spare tires and wheels, which together typically weigh more than two tons. By developing treads that snap onto tires, future tactical fighters might increase their supply of spare tires more than four-fold without increasing the weight they must carry.

Designers of future tactical fighters in general--and the ATF in particular--should investigate designing builtin units to:

- Start the airplanes
- Load ordnance
- Provide air conditioning for the avionics
- Generate electricity, oxygen, nitrogen, and compressed air.

In addition, designers should investigate the possibility of substituting the following materials even if they are less effective or heavier:

- Compressed air for compressed nitrogen
- More conventional fueled power units for those that use Hydrazine
- Less unusual material for HALON or other substitutes for preventing fuel explosions

- Less unusual materials for those that are potential wartime support problems
- Replaceable-tread tires for conventional ones.

None of these proposals involves easy choices. Each will cost money, some will increase the weight of the airplane, and each may raise its own reliability problems. In addition, each must be considered in the context of other basing options and support changes that will be made.

DECREASED RELIANCE ON GROUND SUPPORT PERSONNEL

Finally, increases in equipment reliability and reductions in ground equipment through builtin support should lead to decreases in the number of ground support personnel that must be deployed. These actions will considerably reduce the reliance on on-site maintenance and thus improve mobility, survivability, and sortie generation.

The reliance on local repair to reduce the costs of stocking components with high failure rates creates the need for the specialized equipment and technicians typically found in the AIS. Both usually are in short supply during peacetime, and they undoubtedly will be more so during wartime. If equipment fails or is destroyed or if the necessary maintenance personnel are unavailable, the dependent sophisticated avionics or engine systems necessarily degrade.

In addition to reducing support equipment and associated personnel, there is a need to compress the number of specialists and tasks associated with aircraft turnarounds.

Under the current maintenance system, dispersal of a wing with 72 aircraft to 12 sites (with six airplanes at each site) would require the impractical addition of some 300 to 600 flight line maintenance personnel per wing.

Reduction of this number of maintenance personnel would require changes in the way maintenance procedures are carried out and in the way senior career maintenance personnel are trained.

In both developed areas and the Third World, the ideal weapon system is one that can be maintained with remove-and-replace actions (often referred to as on-equipment-only maintenance) without the need of local repair of failed components. This would require such improvements in equipment reliability as have previously been discussed. With these procedures, flight-line maintenance personnel during wartime would merely need to exchange faulty parts for functioning ones. They would not, however, have to repair the faulty parts. The increased reliability and reduced ground support equipment requirements also set the stage for further changes in logistics support structures. The reduced dependence on local repair can lead to centralized theater repair facilities--or even depot-only repair. These structures coupled with mobile teams of specialized repair personnel would further decrease the reliance on personnel required at the point of sortie generation.

In addition, such improvements in procedures would pave the way for reducing the number of specialty occupations. Senior career maintenance personnel could then receive generalized training (or cross training) rather than merely the specialized training they currently receive. This would allow for more productive personnel at either MOBs or dispersed locations, further decreasing the requirement for maintenance personnel.

The concept of "specialist" has become firmly entrenched in the Air Force's maintenance system. The term "specialist," however, can be misleading because it implies that a maintenance specialist--like a medical specialist--receives both broad general training and subsequent in-depth training in a particular field. The Air Force Specialist, as defined by a single Air Force Specialty Code, receives only a brief technical course (often thought to lack sufficient relevance to subsequent duties) and then training in a very narrow and sometimes minor set of maintenance tasks.

Such a maintenance approach has made sense in the past given the heavy reliance on MOBs with their large work forces and the short time that maintenance personnel are expected to remain in the service. It ensures maximum peacetime productivity for a minimum investment in personnel and training. But this maintenance approach can pose serious

problems if aircraft are dispersed or forced to operate from austere locations.

Training senior career maintenance personnel to perform a variety of tasks could have several advantages. Failures--and therefore maintenance tasks--occur randomly, so particular skills are needed in varying amounts at different times. The more people with the required skills, the better the organization can deal with peaks and slacks in the workload for any given maintenance task. This can promote efficiency.

In addition, if the maintenance staff consists largely of personnel with one or two of a kind critical skills, a few casualties could completely disable a small dispersed unit. The more redundancy of maintenance skills, the better the surviving personnel can service equipment in the face of combat losses and still maintain combat effectiveness.

Finally, changes in the training of senior career enlisted personnel may help alleviate some of the current dissatisfaction among maintenance personnel concerning the nature of their jobs and among pilots and command organizations concerning the quality of aircraft maintenance. Such changes in training and specialty codes will not come easy: They will cost money, at least in the short run, and they will involve major disruptions in the current maintenance system. Changes must be considered in the context of other changes in basing options and support characteristics, and they must rest on careful estimations of the optimal level of generalized skill needed to maintain aircraft during wartime situations.

IV. AN INTEGRATED APPROACH TO BASING AND SUPPORT REQUIREMENTS FOR FUTURE FIGHTER WEAPON SYSTEMS

Giving aircraft the option of being based at long distances from potential enemies or being dispersed to small, austere bases seems to offer large-scale benefits by improving ground survivability and sortie generation. But any such benefits can occur only if aircraft have long combat radii or if squadrons are sufficiently mobile to permit dispersal. Current aircraft lack this mobility primarily because their design has stressed air vehicle performance rather than total weapon system performance.

To determine how changes in total weapon system requirements can lead to the greatest overall benefits, *various alternatives* must be tested in terms of ground survivability, mobility, and sortie generation on the one hand and in terms of dollars and lost air vehicle performance on the other.

The methodological approach we recommend involves investigating five major task areas:

1. STOL and rough field landing capabilities
2. Improved ground survivability from *rearward* or *dispersed* basing
3. Increased equipment reliability
4. Increased aircraft, builtin support
5. Decreased reliance on support personnel from changes in personnel classification and training.

The investigation of these areas requires a major effort to integrate disparate kinds of general information drawn from Air Force and industry sources.

STOL AND ROUGH FIELD CAPABILITIES

To investigate optimal levels of STOL and rough field capabilities, analysis could determine the value of these capabilities for typical scenarios in the Third World and in builtup areas such as Europe.

In Third World scenarios, there is a natural tradeoff between operating from a few MOBs and operating from a larger number of austere but geographically more distributed "bush" strips. MOB operations create ground survivability problems (although some might be overcome by good ground defense) and require fighters to have greater combat range because projected engagements in the Third World will often be remote from MOBs. By contrast, operations from bush strips may not only improve survivability through dispersal but will also decrease the range to be flown. Yet such operations will require at least some level of STOL and rough field capabilities because bush strips by their very nature will be short and rough.

To assess these tradeoffs, research would first have to identify representative countries and battle scenarios for likely U.S. involvement. To locate a set of feasible MOBs and bush strips for such involvement, information would have to be collected on the roads and seaports that could resupply them. Then for different levels of operations, one could determine needed levels of combat range and STOL/rough-field capabilities. Finally, the costs of these levels could be computed in terms of dollar decreases in other air vehicle performance characteristics and the need for ground defense.

In European scenarios, there is a similar tradeoff, in this case between operating from MOBs and dispersed operating bases. Here, STOL/rough-field capabilities allow airplanes to operate not only from MOBs and COBs with damaged runways but also from austere dispersed locations associated with projected COBs and MOBs.

To assess these tradeoffs, one could characterize representative enemy attacks using the kinds of advanced runway munitions projected to be available circa 1990. For a constant fleet size, one could then compute the survivability of runways for one MOB versus the larger set of austere dispersed locations. (This analysis would also need to consider resources for runway repair and the costs of various STOL

capabilities.) As is shown below, such research could--among other things--determine a band of near optimal STOL levels.

The following figures illustrate how research can isolate a small band of optimal capabilities. The band--in this case involving optimal STOL capabilities--can then be used in subsequent analyses involving such options as rough field landing capabilities, rearward basing, dispersed basing, increased reliability of equipment, increased builtin support, and decreased reliance on support personnel.

Such an approach uses a "winnowing" process. Rather than attempt to handle all variables at the same time, it looks first at one set, then at another. This process keeps the research from becoming too complicated and time-consuming to be completed. In addition, it assumes only a limited number of typical basing modes: (1) basing at MOBs (which involves no dispersal), (2) basing at large dispersed site with 12 aircraft (DOB_1), and (3) basing at a small dispersed site with six aircraft (DOB_2).

Please note that all figures use *hypothetical* information. They demonstrate how research data can potentially define optimal changes in basing options and support requirements. Thus they picture a research approach, not the products of that research:

> Using 95 percent and 75 percent confidence bounds, *Fig. 1.a* shows the number of enemy sorties needed to close an airfield at three levels of dispersal (e.g., one base of 72 aircraft, six bases of 12 aircraft, and 12 bases of six aircraft) given different field lengths divided by different STOL capabilities (e.g., 2000 ft capable aircraft operating from a 4000 ft field).
>
> *Figure 1.b* shows the number of lost sorties at different levels of dispersal given different investments in rapid runway repair (and in point ground defense). Several of these would need to be developed for the different STOL capabilities.

Figure 1.c uses the information in Figs. 1.a and 1.b to estimate the sorties a wing can fly given different levels of STOL and different levels of dispersal. Several of these would need to be developed for different dispersal field lengths and different investments in rapid runway repair.

Figure 1.d incorporates the dollar costs of different levels of STOL in terms of the wings that can be purchased for a fixed budget. For example, we might purchase seven wings of aircraft for $20 billion given they meet a 5000 ft takeoff criterion but only four if they meet a 500 ft criterion.

Figure 1.e finally balances the dollar costs (in terms of total sorties flown from a particular runway for a fixed budget) against reduced capabilities at different levels of STOL and different levels of dispersal (DOB_1 and DOB_2). Such a function incorporates the fact that greater STOL capability yields more survivability but, because of its cost, decreases the number of airframes that can be purchased. The data from similar figures should identify a narrow band of optimal STOL capabilities to be pursued in conjunction with other design and support improvements.

IMPROVED GROUND SURVIVABILITY FROM BASING ARRANGEMENTS

Rearward Basing

Rearward basing can improve ground survivability, but it requires increased combat range capabilities for fighters to operate out of such bases. To investigate optimal levels of combat range capabilities, for various distances of rearward basing (500 and 1000 miles from the target, for example) research could examine the decreased vulnerability that would result from the enemy's decreased ability to attack these bases. A prime measure of the effectiveness of rearward basing would be the number of sorties that could be flown in the face of enemy attack. Because range and speed affect the number of sorties flown, the investigation would have to estimate increases in vehicle speed that can

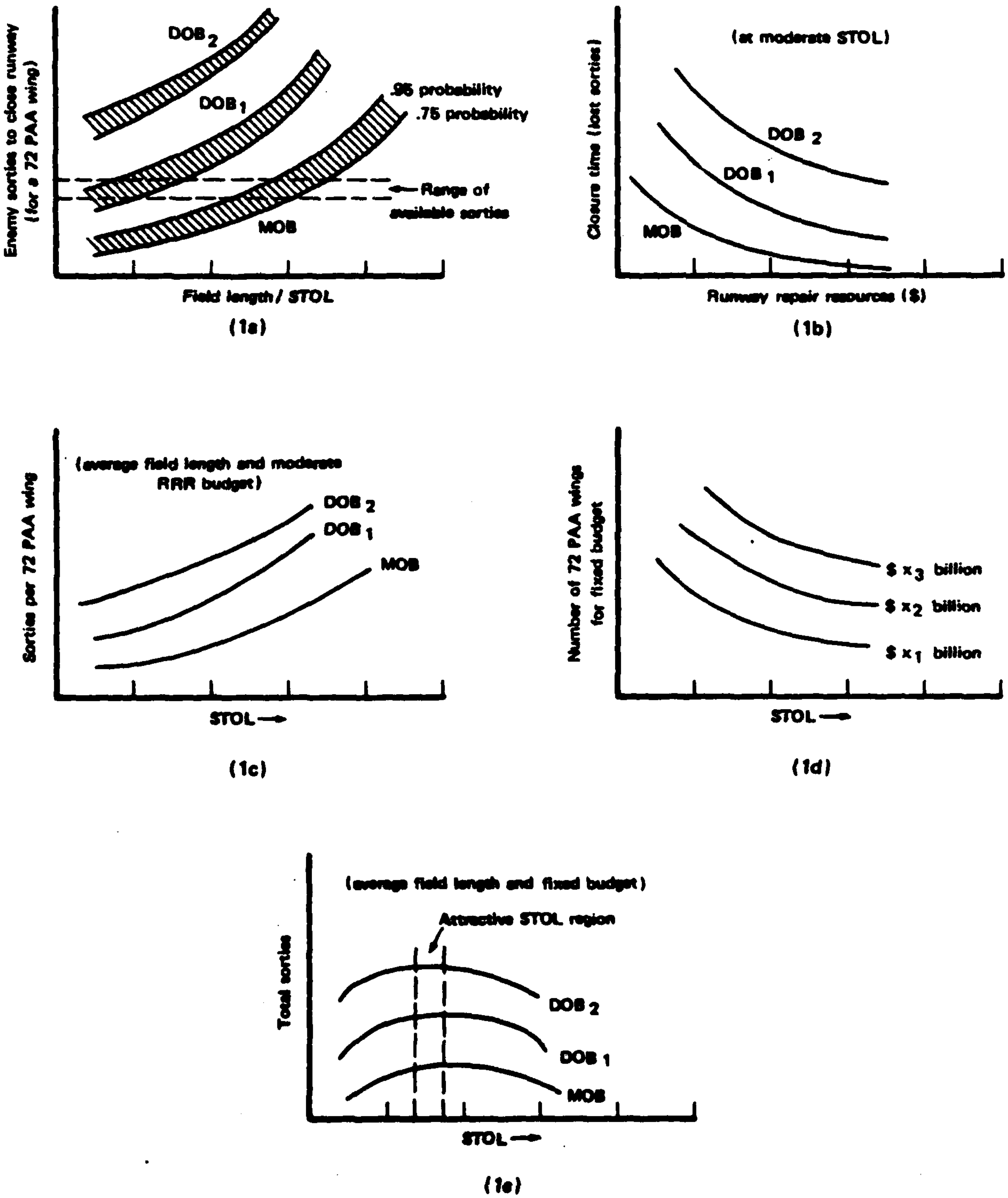


Fig. 1 — Determining needed STOL in terms of runway length, dispersal, and investment (STOL and runway repair)

be expected from technology and the costs of these increases. Using a cost tradeoff analysis, such an investigation would also have to determine whether increases in combat range can be achieved purely by design or by the use of air-to-air refueling.

Dispersed Basing

Then for various levels of dispersal (dispersing a 72 aircraft wing to six, 12, and 18 locations, for example), research could determine the increased requirements and costs not only of buildings, support equipment, spares, fuel, personnel, and the like, but also of transportation, communications, and resource control among dispersed locations. In addition, one would need to determine the relative vulnerability of dispersed bases to likely kinds of attacks on facilities as measured by numbers of sorties generated and by numbers of people and aircraft incapacitated. Vulnerability and overall costs might be further reduced at dispersed bases by increasing aircraft reliability, decreasing needed ground support, and combining skills for various maintenance personnel. (These possibilities are discussed in more detail in task areas 3, 4, and 5.) Finally, research could determine the relative vulnerability of rearward MOBs, dispersed locations, and enhanced MOBs from weapons and attacks projected for the 1990s. Such research would compare the relative damage to aircraft, test equipment, builtin ground support equipment, and runways (covered in task area 1). In addition, estimates could parametrically account for possible increases in area, point, and passive defenses that might make MOBs less vulnerable, and research could quantitatively investigate the enemy's ability to detect and attack rearward MOBs and dispersed locations.

By its very nature, this sort of analysis quantifies only the most tangible items. However, some attempt must be made to incorporate less tangible factors such as the difficulty of acquiring new operating rights in crowded European countries.

INCREASED EQUIPMENT RELIABILITY

To investigate optimal increases in equipment reliability, a research program could identify the components and AGE that currently account for the major maintenance actions and equipment costs. Then based, for example, on two- and five-fold improvements in the reliability of this equipment, one could estimate the effects on support resources and on ground survivability at MOBs and austere dispersed locations. Simultaneously, research is required on such methods as the "maturational development approach to avionics" to achieve such reliability gains and on estimates of the costs of these methods.

INCREASED ONBOARD BUILTIN SUPPORT

To investigate optimal increases in builtin support equipment, research could determine the marginal dollar and air vehicle performance costs to develop, service, and use such onboard builtin support as

- Oxygen generation
- Nitrogen generation
- Electrical generation
- Air conditioning and heating
- Hydraulics
- Munitions hoists
- Ammunition loading
- Engine starting.

Using this information, a research program could determine how these onboard builtin support systems would affect ground survivability (measured in terms of sorties generated as discussed in task area 2).

DECREASED RELIANCE ON SUPPORT PERSONNEL

To investigate optimal decreases in reliance on support personnel, research could determine the feasibility and effects of reducing the number of Air Force Specialty Codes (AFSCs) for flight line maintenance to numbers ranging between four and 15 rather than the current 22. Using this information, it could then identify candidate requirements

and programs for those training organizations that could use these reduced numbers of AFSCs. Finally, it could identify potential problems that each of these training programs might pose and devise appropriate solutions to these problems.

INTEGRATING ALL FIVE TASK AREAS

The following figures illustrate how the information derived from all five task areas can be integrated to isolate optimal improvements for future tactical fighter weapon systems.

Again, these figures use *hypothetical* information. They demonstrate how research can define optimal changes in basing options and support requirements. They do not show conclusions of any research:

> Using a constant number of sorties per wing, *Figure 2.a* calculates the costs of aircraft and basing resources needed for various levels of dispersal and rearward basing given the current basing posture (base case), improved reliability, decreased reliance on support personnel, and increased builtin support equipment.
>
> *Figure 2.b* shows the number of sorties that can be flown when bases (at various levels of dispersal and rearward basing) are under attack given the current basing posture (base case), increased builtin support equipment, improved reliability, and the addition of STOL.
>
> *Figure 2.c* estimates the cost to a standard 72 aircraft wing of improvements in reliability, builtin support, and STOL.
>
> Using a constant number of sorties per theater, *Figure 2.d* then combines Figs. 2.a-c. to show the additional costs at various levels of dispersal and rearward basing for the base case, increased builtin support equipment, improved reliability, and the addition of a STOL.

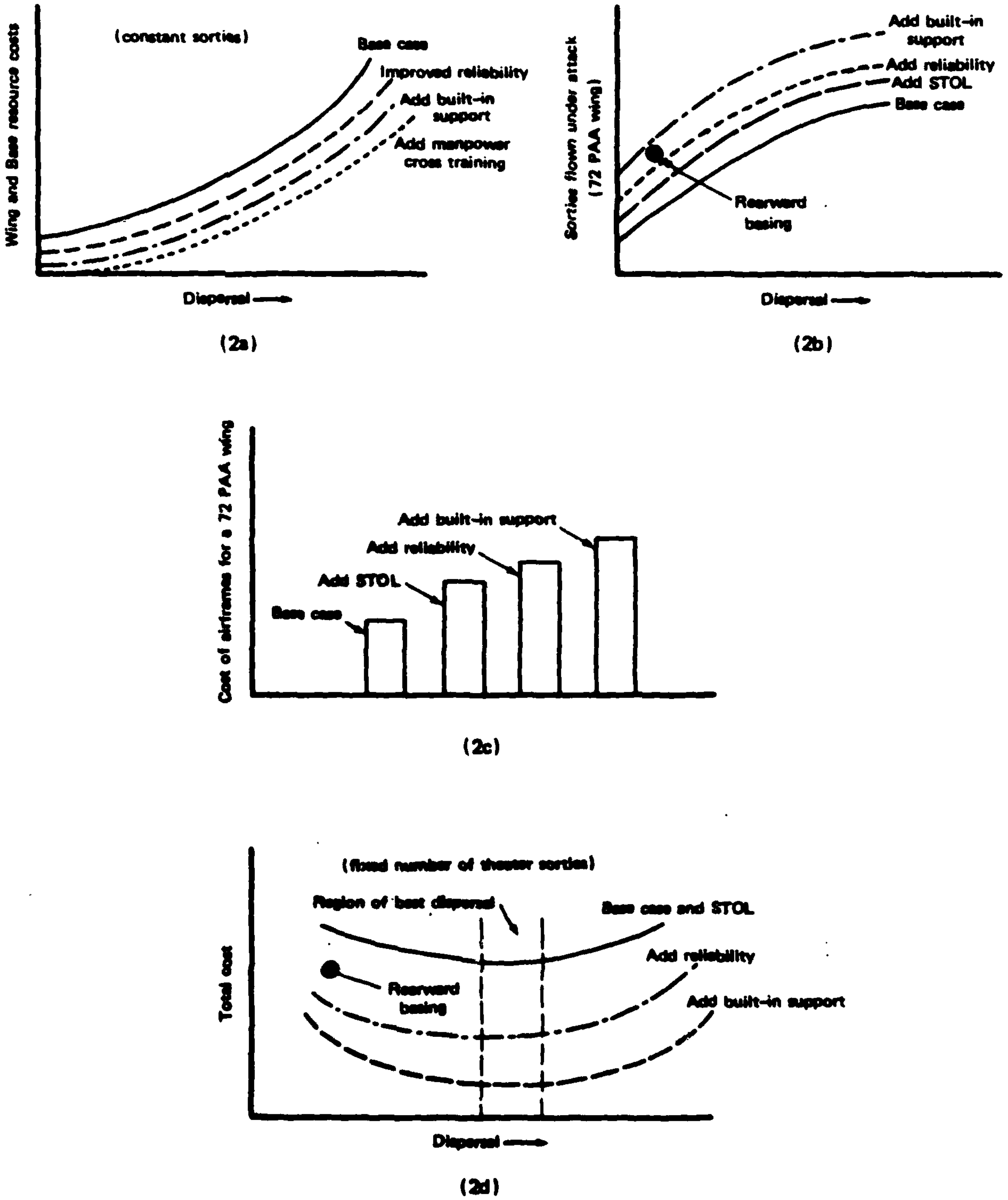


Fig. 2 — Integrating cost and ground survivability information

Ideally, such a research approach should yield three valuable kinds of conclusions. First, it should identify the value of varying levels of dispersal or rearward basing for future tactical fighters in general. Second, it should identify the costs (in terms of money spent and performance lost) of support requirements necessary to achieve ground survivability and sortie generation at various levels of dispersal or rearward basing. Finally, it should ensure an integration of weapon system characteristics so that future tactical fighters will have the best chance of deploying, generating needed sorties, and surviving in future combat situations.

V. CONCLUDING REMARKS

This Note has argued that the Air Force needs to define weapon system performance more broadly than in the past by including basing and support characteristics along with air vehicle performance.

Any changes in basing and support also affect air vehicle design and its performance. Thus a methodology is needed to integrate basing, support, and air vehicle characteristics in order to achieve optimal ground survivability, mobility, and sortie generation.

This Note advances the concept of a research program that would use such a methodology to achieve this integration. The research program fits in with the concept development provisions of AF Regulation 57-1 ("Statement of Operational Need") and could be adopted during the concept development phase of the ATF. Rand will undertake a modest effort primarily directed toward developing a research methodology to handle these concerns. Rand is prepared to assist the Air Force and industry in their detailed explorations of alternative concept for logistics support of the ATF. It is hoped that this Note will aid them in structuring and evaluating those alternative concepts.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER N-1985-1-AF	2. GOVT ACCESSION NO. AD-A129039	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Increasing Future Fighter Weapon System Performance by Integrating Basing, Support, and Air Vehicle Requirements		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) M. B. Berman with C. L. Batten		8. CONTRACT OR GRANT NUMBER(s) F49620-82-C-0018
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Rand Corporation 1700 Main Street Santa Monica, CA. 90406		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Requirements, Programs & Studies Group (AF/RDQM) Ofc, DCS/R&D and Acquisition Hq, USAF, Washington, D.C. 20330		12. REPORT DATE April 1983
		13. NUMBER OF PAGES 26
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

No Restrictions

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Fighter Aircraft
Military Air Facilities
Requirements
Planning

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

See reverse side

DD FORM 1 JAN 73 1473

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

This Report

Argues that the Air Force should consider alternative basing and support characteristics before completing concept formulation for the Advanced Technical Fighter. In so doing, the Air Force could integrate these characteristics using a methodology described in this Note. This methodology aims at identifying the best match between specific air vehicle characteristics and such basing and support improvements as dispersed and/or rearward basing, short-take-off-and-landing and rough-field-landing capabilities, increased combat range capabilities, improved equipment reliability, and decreased reliance on support equipment and personnel. The proposed methodology involves two stages: (1) indentification of necessary individual improvements paid for with the least money and the least decrease in overall aircraft performance, (2) integration of all improvements to ensure the greatest overall weapon system improvements. This integrated approach implies a new definition of "weapon system performance," one that involves no merely air vehicle characteristics (like velocity and acceleration) but also basing and support characteristics.

END

DATE
FILMED

7-83

DTIC